feet, so that the Daphnias were far less directly illuminated by the scattered light.

As in the preceding case, I placed by the side of it a similar cell containing water, and suspended them side by side over the water containing the Daphnias, and reversing the position after each experiment. The numbers were as follows :—

	Under the sulphate of quinine.	Under the water.
Exp. 1.	13	47
,, 2.	17	43
,, 3.	12	48
,, 4.	11	49
,, 5.	20	40
,, 6.	18	42
,, 7.	20	40
,, 8.	15	45
	126	354

Although the contrast in this latter series is not so great, still it is unmistakable. It seems to me, therefore, though I differ with great reluctance from so eminent an authority as M. Paul Bert, that the limits of vision of Daphnias do not, at the violet end of the spectrum, coincide with ours, but that the Daphnia, like the ant, is affected by the ultra-violet rays.

GLACIERS AND GLACIAL PERIODS IN THEIR RELATIONS TO CLIMATE [1]

NOW that the *effects* of glacial action, present and past, have been so well studied, the question as to *causes* deserves to be more attentively considered, and it seems that meteorologists must now take it in hand, having too long neglected it. A cursory glance on the present conditions of our globe shows us that cold alone will not produce permanent snow and glaciers when vapour of water is deficient. There are no permanent snow nor glaciers in the Verkhojansk Mountains in North-East Siberia, yet at the foot of them the mean annual temperature is below 4° F., and that of January below – 56° F. The reason is that the snowfall is but small, and thus the snow is easily melted in summer. In New Zealand, on the contrary, owing to the enormous snowfall in the mountains, glaciers descend to about 700 feet above sea-level on the west side (lat. 43° S.). At this height the mean annual temperature must be about 50° F., and snowfall and frost are of rare occurrence, even in winter.

The great importance of an abundant supply of vapour admitted, and thus the necessity of surfaces covered by sea, what temperature of the surface of the seas is the most favourable to the production of glaciers? This depends certainly on the height above sea-level where the *nevé* is formed; but so far as we consider lowlands and moderate heights, say below 6000 feet, the surface temperature of the water should not very much exceed the freezing point, otherwise the vapour evaporated from the sea and condensed on the surrounding lands will be rain, and not snow, thus contributing rather to melt the existing snow and not to form new snow-layers. For lowlands and very small elevations a temperature of the surrounding seas of about 32° F. is that which is most favourable to the formation of snow, and if the last is falling in sufficient quantities to form permanent snow and glaciers.

The deeper and opener the seas are, the better, for such seas do not freeze entirely, as the winds and tides always break the ice which is already formed; thus seas of that kind have, even in the midst of winter, a considerable open surface, which evaporates freely. Shallow seas surrounded by land can be entirely frozen in winter, and thus the ice and snow which cover them, considerably cooled by radiation and cold winds from the land, evaporate but very little, and are by far less favourable to a great precipitation of snow and ice. Thus the cold of winter in mediterranean seas is a condition very unfavourable to a great evaporation from their surface in the cold season, and to a heavy snowfall on the surrounding land. With the premises given above it will be easy to understand the difference in the extent of ice-sheets and glaciers, or their total absence in the different regions of our globe at the present time, as well as the probable causes of former glaciation.

Abstracting for once from the polar regions of the southern hemisphere, of which we know but little, we see that in the higher latitudes of the southern hemisphere (40°–67°) the extent of seas is much greater than in the same latitudes of the northern hemisphere. We know, further, that the seas of these latitudes receive considerable quantities of warm water from tropical seas. Now the south tropical seas do not exceed so much in extent the north tropical seas, then the seas between 40°–67° S. exceed the seas between 40°–67° N. If the latter were even to receive the same relative proportion of warm water from the tropical seas of their own hemisphere than the southern seas of the same parallels, the thermal effect would be yet greater, on account of the limited extent of the seas between 40°–67° N. But the greater extension of the south-east trades and their existence even to the north of the equator pours a great quantity of the warm water of the southern tropical seas into the seas of the north temperate zone, thus giving probably an equal if not a superior quantity of warm water to seas of not half the extent. How much this must tend to raise the temperature of the seas between 40°–67° N. is easy to see. This explains why there is so little permanent snow in these northern latitudes in the proximity of the sea, notwithstanding the great precipitation existing there, and the greatest quantity of it falling in the colder part of the year. The temperature of the sea-surface is so high, that much more rain than snow falls even in winter. Let us take an example. The sea-surface between the south-west of England and the south of Ireland has a temperature of above 50° F. even in January. Supposing a saturated stratum of air to rise from these seas, it would have cooled down to about 38·4° F. at an elevation of 4000 feet, that is at the level of the highest peaks of the British Islands.[1] The resulting precipitation will be rain and not snow. Thus a broad and swift atmospherical current from the south-west will give rain and not snow, even in the mountains of England and Scotland. As the south-west are the prevailing winds the absence of anything like permanent snow is easily understood. In Norway, where the surrounding seas are colder and the elevations greater, permanent snow and glaciers do exist. Greenland, which is surrounded by much colder seas, yet never entirely frozen, has an ice-sheet covering all the interior and forcing glaciers to the sea. The height of the ice-sheet is so great, and the sea so cold, that probably even in summer the precipitation is always snow in the interior. As the seas near Greenland are not warmer than 41° F. in summer, a saturated stratum of air rising from them will have a temperature of about 31·1° F. at a height of 3000 feet, that is, much below the level of the ice-sheet in the interior.

The seas between 40–67° S. have generally a much lower temperature than the northern seas of the same latitude (see, for example, the map in Wild's "Thalassa.") Thus their conditions are much more favourable to the production of snow at small elevations above the sea-level, and owing to the small difference of the temperature of winter and summer in so strictly oceanic climates, snow will fall even in summer. This explains why we find so great sheets of ice and glaciers descending to sea-level in all lands and islands south of 50° S. (the eastern part of South America, the Falkland and Auckland Islands excepted).

As there is either a continent or a great cluster of high islands in high southern latitudes, and as the seas north of it give great quantities of moisture to be condensed to snow, a glaciation exceeding all that is known in the north hemisphere is the result, and the glaciers, descending to the sea, and their broken ends floating to the ocean as icebergs, they in their turn cool the sea water, and thus bring about temperatures favourable to the formation of snow. Thus cause and effect react on each other, as is so often the case. We know besides that the southern seas do not freeze to a great extent, so that ice-fields, so frequent in higher northern latitudes, are far less common in the south, the icebergs being the prevailing form of ice there. This shows us that there is, on the southern seas, always a great extent of open water, and thus an active evaporation.

In the northern hemisphere, on the contrary, the colder seas are mostly shallow and surrounded by land, and thus frozen over to a great extent in winter (for example, the White and Kara Seas, the Sea of Okhotsk, Hudson's Bay, the bays and straits between the archipelago of North America). Thus the evaporation is checked just at the time most favourable to a heavy snowfall.

The continents of the northern hemisphere are too extensive, too little open to the influences of the sea and its moisture, to have extensive ice-sheets. The example of mountains in North-East Siberia shows this very well. Similarly the great interior

[1] Short analysis of my paper under the same title, published by the *Zeitschrift der Gesellschaft für Erdkunde* in 1881.

[1] On the Thermal Conditions of Rising and Descending Strata of Air. See Guldberg and Mohn's "Etudes sur les Mouvements de l'Atmosphère."

plateaux in the centre of Asia, north of the Karakoram and east of the Pamir, are too dry for glaciers, notwithstanding the height of the mountains rising over them. The continental parts of Eastern Asia (that is China, Mandchooria, the Amoor provinces, &c.) have more moisture, but it falls nearly entirely in summer, and, owing to the high temperature of the continent at this season, rain, and not snow, prevails to the height of 12,000 or even 15,000 feet. The winter is the time of the north-west monsoon, which brings cold but dry weather, with a cloudless sky. The monsoon climate of these regions, that is the prevalence of cold, dry winds in winter and moist winds in summer, being the result of the geographical conditions, it must have prevailed since the great features of the centre and east of Asia were as they are. The existence of the plateaux and elevations to the south and west of them is especially important. As all geologists are agreed that at least since the Pliocene period this has been the case, I must conclude that the monsoon climate existed in Eastern Asia the whole time, and thus conditions exceedingly unfavourable to an accumulation of permanent snow and glaciers. It is well known that Pumpelly and Baron Richthofen did not find any traces of former glacier action in China or on its western and northern borders; neither did Dr. Schmidt find any in the Amoor provinces. Thus geological and climatological evidence are perfectly agreed, the first showing that there were no glaciers, and the second why there were none. As to the plateaux of Central Asia, they must have been exceedingly dry since the rise of the Himalaya and Karakoram to the south and the Pamir heights to the west of them, and thus have had nothing corresponding to the later glacial periods of Europe and North America. The geological evidence, especially the studies of Stoliczka, confirms this.

As to the former glaciation of Europe and North America, the conditions which must have led to it are, in general, greater cold in regions which have now an oceanic climate with heavy precipitation, and a more oceanic climate in regions which are cold enough, but where the rain and snow are now too deficient, especially in the cold season. Great Britain belongs certainly to the former class, that is, there is moisture enough, but, owing to the warm seas surrounding the islands, the temperature is too warm for glaciers. Thus a diminution of the quantity of warm water brought from the tropical Atlantic, or a change of these currents so as to stop their influence on Great Britain altogether, are the principal conditions needful to bring about a heavy snowfall, first in the mountains, and then even on more moderate heights, and to render the snow persistent. A change of the same kind would increase the present glaciers of Norway, enabling them to reach the sea even south of the 60° N., and give rise to new glaciers.

It is now pretty certain that all Scandinavia, Finland, North-West Russia, and Northern Germany were covered by a sheet of ice which gradually filled the Baltic and North Seas and reached west of Great Britain, to where the depth of the Atlantic is now about 600 feet. Many geologists would have the whole extent of country standing much higher to initiate such an intense glaciation. I would not object to this for the mountainous districts, those of Scandinavia especially; but there is decidedly no proof of it for the plains, and the arguments from a climatological point are strongly against such a supposition. A rise of less than 600 feet in North-West Europe would empty the Baltic and North Seas, and extend the Continent to much beyond Ireland. This would give to Königsberg in Prussia a climate as continental as that of Orenburg on the borders of the Kirghiz steppes. Such a dry climate would be so unfavourable to permanent snow and glaciers, that no amount of rise of the land would outweigh it.

I suppose, on the contrary, that a rise of the seas or a sinking of the land had very much increased the extent of country covered by the sea, and besides giving access to the cold water and ice of the Arctic Ocean through what now are the Lakes of Ladoga, Onega, and the White Sea, brought a moist and cold climate to the whole region. Thus an accumulation of snow and ice was brought about first on the highlands, and the ice by and by expelled the waters of the shallow seas (the present lowlands of North-West Russia, Scandinavia, and North Germany) and then of the somewhat deeper seas (the present Baltic and North Seas). As the ice advanced, the elevation of its interior part and the cooling due to the presence of snow and ice counterbalanced the greater distance of the sea, favouring a heavy snowfall even in summer, *i.e.* giving the conditions which now exist in the interior of Greenland.

Similarly in North America the submersion of a part of the Western plains, uniting Hudson's Bay to the Gulf of Mexico, was necessary to the beginning of intense glaciation. A vast extent of cold sea was thus called into existence in the West, and as the westerly winds are very prevalent and strong there, this must have caused a heavy snowfall during the greater part of the year. It is known that even now the precipitation of rain and snow is very heavy in the United States and part of Canada from the Atlantic to the Mississippi, so heavy that it it is unequalled by any extensive region of the globe under the same latitudes. Besides, the cold sea to the West went far to prevent the influence of the hot and dry summer temperature on the plains between the Rocky Mountains and the 100° W. or even beyond. American geologists have shown how closely the ice-sheet conformed to the present amount of precipitation, there being a "driftless" region in Wisconsin, which is now drier than the surrounding country, having less than thirty-two inches of precipitation in the year, and of four in winter.[1] The same relation is to be found in the Old World wherever the phenomena are better studied; glaciation was more extended in the moister Western Alps than in the drier Eastern Alps; it was less in the Caucasus and Central Asia (*i.e.* the part west of the Pamir and Thian-Shan) than in the Alps, &c.

I have now to consider the possibility of so-called ice-caps reaching in an unbroken sheet from the Pole to a latitude of 45°–50°. All I mentioned before leads to the conclusion that they are impossible, as on extensive and deep seas an accumulation of ice is impossible, as the ice is immediately broken by winds, currents, and tides, and on great continents the climate is too dry. Thus now there is nothing like an extension of ice of that kind in the southern hemisphere, because the greatest part of the latitudes above 45° are open ocean, and on the northern because the continents are too dry. And the one or the other cause always must have prevented an extension of ice of a magnitude as stated above, and mostly probably there were both too extensive continents and too great and deep oceans to allow of an accumulation of ice on a very great part of them at the same time. Thus a displacement of the centre of gravity due to ice of the magnitude supposed by Mr. Croll on this hypothesis, is inadmissible. But one thing is worthy of remark in this hypothesis: it is the search for a cause which may explain the changes of the level of the sea, which certainly have taken place on the globe, and which are now explained as due to the rise or subsidence of the land on the Lyellian hypothesis of the stability of the sea-level.

The influence of a high eccentricity on the accumulation of snow and glaciers has next to be considered. This is a question which has been considered especially by British geologists, and the majority of them agree in attributing a great influence to that cause, and in thinking that with the winter in aphelion during a high eccentricity there existed conditions favourable to an accumulation of ice.

Let us take the simplest conditions, those in the interior of a great continent, for example, Asia. We should expect then, during high eccentricity, a greater cold in mid-winter, and greater heat in midsummer when winter is in aphelion. A greater cold in winter would not be conducive to an accumulation of snow, while a more intense heat in midsummer would probably melt the snow at heights where at present temperature does not rise much above 32° F. In the monsoon regions a colder winter in the interior, with the accompanying higher pressure of the air, would intensify the cold and dry winter monsoon winds, and thus bring about conditions even less favourable to an accumulation of snow. Greater heat in summer in the interior of Asia would intensify also the moist summer monsoon, and thus give a greater amount of precipitation. But owing to the small amount of snow falling in winter and its rapid melting, the temperature would rise over 32° F., even at considerable heights, greater than now, and the precipitation due to the moist winds would be rain. Thus, in the interior and eastern part of a continent like Asia, winter in aphelion during a high eccentricity would be less favourable than even the present conditions to permanent snow and glaciers.

As to the western parts of continents and to islands, they are more fully under the influence of the seas. As there is no reason to suppose that the surface-temperature of the sea would be lower during winter in aphelion and high eccentricity, it follows that there will not be more snow than now in countries where rain is the rule, even in winter, all other things equal. As

[1] A. Dana in *Sill. Journ.* c. xv. p. 250.

there is also nothing in these astronomical changes to intensify the moist (principally westerly) winds in winter, there will also not be a greater quantity of snow falling at that season in regions having a regular covering of snow in winter. The greater heat and rarefaction of the air in the interior of continents in summer will cause the air of the oceans to flow thither with greater force, and such a movement of the air is favourable to more abundant summer rains than are experienced now, and thus to a melting of the snow in mountainous countries.

Thus it would seem that winter in aphelion during high eccentricity would have rather the opposite effect to that which is generally attributed to it, but it seems to me that the effect would be in any case but slight, and not by far to be compared to that of the distribution of land and sea, mountains and lowlands; in other words, to that of the geographical conditions. With the change of these the extent and distribution of snow and ice must change also.

An attentive study of the physical geography of the earth and of its influence on climates, together with a judicious application of the simplest physical theories, will enable us to gain by and by a better knowledge of geological climates. The problem is an arduous one, but now that the studies are directed in the right way, there is no doubt of the final success.

A. WOEIKOF

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

AT a recent meeting of the trustees of the Mason College in Birmingham, the executors of Sir Josiah Mason presented a statement showing the amount to which the college will be entitled under the will of Sir Josiah Mason. After paying claims on the estate and providing for legacy duty, about 20,000*l.* will accrue to the college within the next three years, and after certain life interests are satisfied, a further sum of about 15,000*l.* will be available, making a total of 35,000*l.* for the estate. The benefactions of Sir Josiah Mason to the college building, endowment, and legacies will then amount to a total of 210,000*l.* The building and endowment of the orphanage and almshouses represent a sum of about 260,000*l.*

IN our University Intelligence last week, in the paragraph relating to Prof. MacAlister's lectures, the word *chemical* should have been *clinical*.

SCIENTIFIC SERIALS

The American Naturalist, December, 1881, contains—F. M. Endlich, on Demerara.—C. E. Bessey, a sketch on the progress of botany in the United States in 1880.—J. D. Caton, the effects of reversion to the wild state in our domestic animals.—W. R. Higley, on the microscopic and general characters of the peach tree affected with the "yellows" (concluded).—W. H. Dall, on intelligence in a snail.

January, 1882.—S. A. Forbes, on the blind cave-fishes and their allies (a new species of Chologaster, *C. papilliferus*, from a spring in Southern Illinois, is described).—Dr. C. F. Gissler, on a singular parasitic Isopod (*Bopyrus palæmoneticola*, Packd.), and on some of its developmental stages (this interesting species, which is figured, was found on about 10 per cent. of the common prawns (*Palæmonetes vulgaris*) examined.—William Trelease, on the heterogony of *Oxalis violacea*.—J. M. Anders, Forests, their influence upon climate and rainfall.—A. S. Packard, jun., glacial marks in Labrador (with a plate).

THE last number of the *Journal of the Russian Chemical and Physical Society* (vol. xiv. fasc. 1) contains, besides the minutes of proceedings, papers on the constitution of compounds of the indigo group, by M. Lubavin; an interesting paper on the influence of molecular weight of homologues in the so-called incomplete reactions, by Prof. Menshutkin; on Caucasus naphtha, by MM. Markovnikoff and Ogloblin; on the distribution of magnetical currents, by M. Sloughinoff; and on the electromagnetic theory of light of Wm. Maxwell, by M. Borgman.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, January 26.—"An attempt at a Complete Osteology of *Hypsilophodon Foxii*," by J. W. Hulke, F.R.S. Abstract.

After a reference to papers descriptive of parts of the skeleton of this dinosaur, by Professors Owen, Huxley, and himself, the author gives a detailed description of the skull, vertebral column, shoulder, and hip-girdles, with their appendages. The skull is essentially lizard-like, both in its general form and in its structural details. The frontal is a paired bone. The premaxillæ send upwards mesial processes separating the external nares; the exclusion of the maxilla from these nares by the external ascending process of the premaxilla is apparent more than real, since the maxilla is prolonged forwards beneath this process, and comes into close proximity to the nostril. The supra-occipital enters into the foramen magnum. The palate fissured nearly in its whole length is strictly lacertilian. The presence of simple cylindrical teeth in the premaxillæ, of small, compressed teeth in the front of the maxilla and in the mandible, and of larger, more complex, compressed teeth behind these, foreshadow the incisors, premolars, and molars of the higher vertebrates. The vertebræ are opisthocœlous in the neck, planocœlous in the trunk and loins, and amphicœlous in the tail. In the neck and thoracic region of the vertebral column the ribs are forked. In the loins a simple unforked riblet is anchylosed to the end of the transverse process. The sacrum comprises five vertebræ. The ilium has a very long preacetabular process. The femur is shorter than the tibia; the inner trochanter is long and acutely pointed. The tibia has a stout præcnemial crest. The tarsus consists of two bones that together form a sinuous hollow upper surface, in which the tibia and fibula rest; the outer bone representing the os calcis supports both bones of the leg, whilst the inner, representing the astragalus, bears the tibia only. In two feet evidence of two elements of a distal row of tarsalia was found in the outer side of the foot. There are four functional toes with 2, 3, 4, 5 phalanges counting from the inner side of the foot, and a styliform rudiment of an outer metatarsal, devoid of phalanges. This alone demonstrates the generic distinctness of *Hypsilophodon* from *Iguanodon* in which, as is well known, the hind foot comprises only three functional toes. The ungual phalanges are sharply pointed. The sternum is rhomboid. The scapula and coracoid have a general resemblance to those of Iguanodon. The humerus has a considerable deltoid crest, and is shorter than the femur. The radius and ulna are shorter than the humerus. The ungual phalanges of the digits resemble those of the hind toes, but are smaller.

Physical Society, February 25.—Prof. G. C. Foster in the chair.—New Members: Prof. G. F. Fitzgerald, Trin. Col. Dublin, Mr. C. Richardson, Lieut. H. J. Dockrell, R.N., Mr. W. Ford Stanley, General H. Hyde, R.E., Mr. J. Buchanan.—Prof W. E. Ayrton, F.R.S., read a paper on Faure's accumulator, giving the results of experiments made by him and Prof. Perry on the efficiency, storing-power, and durability of the battery. The efficiency was got by measuring the power put in, and comparing it with that taken out, by means of Perry and Ayrton's voltameter and ammeter. The authors found that the cell has great resuscitating power if left insulated after all the current appears to have been discharged. Care had to be taken to see that the cell was quite discharged by letting it stand on open circuit for intervals and discharging between whiles. When this was done they found that the total loss for charges up to one million foot pounds need not be greater than 18 per cent. With slower charges they got a loss of only 10 per cent. As to the storage, a mean current of 18 amperes gave, after eighteen hours' discharge (six hours on three consecutive days), 1,440,000 foot pounds of work equivalent to 1 horse-power in forty-three minutes. The cell contained 81 lbs. of red lead, thus making a capacity of about 18,000 foot pounds per lb. of red lead. The cell showed no deterioration after two months of work.—Prof. Ayrton then described a new form of his dispersion photometer, which greatly reduces it in size and convenience. The principle of this instrument has already been described to the Society by the author. It consists in using a concave lens to disperse the stronger light, and thus obviate the necessity of putting it at a great distance if it is very powerful, such as an electric light. The powers of the two lights are compared by the eye in estimating the intensity of the shadows of a rod thrown on a white screen of blotting-paper by the two lights simultaneously. A sperm candle is used as the standard, and it is placed on a movable stand at an angle to the path of the other beam through the lens. Both the lens and candle can be shifted to and from the screen along a scale giving their distances, and the stronger beam is reflected from a small mirror. This mirror is ingeniously fixed so as to reflect the ray from the